Exploring the Dynamics of the Simple Pendulum

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1. Introduction

Question 1

You pull a simple pendulum 0.240 m long to the side through an angle of 3.5º and release it. (a) How much time does it take the pendulum bob to reach its highest speed.? (b) How much time does it take if the pendulum is released at an angle of 1.75º instead of 3.5º?

Answer:

I. Introduction

Question 1

a) time taken by the pendulum to reach the highest speed is:

↳ $t = T/4$

$t = (1/4)\, 2\pi \sqrt{\frac{L}{g}}$

$t = (1/4)\, 2\pi \sqrt{\frac{0{,}24\ m}{9{,}8\ m/s^2}}$

$t = 0{,}246$ secs

b) $t = 0{,}246$ secs aswell;

↳ The time is the same for both answers, since only the length of the pendulum effects the time and not the angle of pulling.

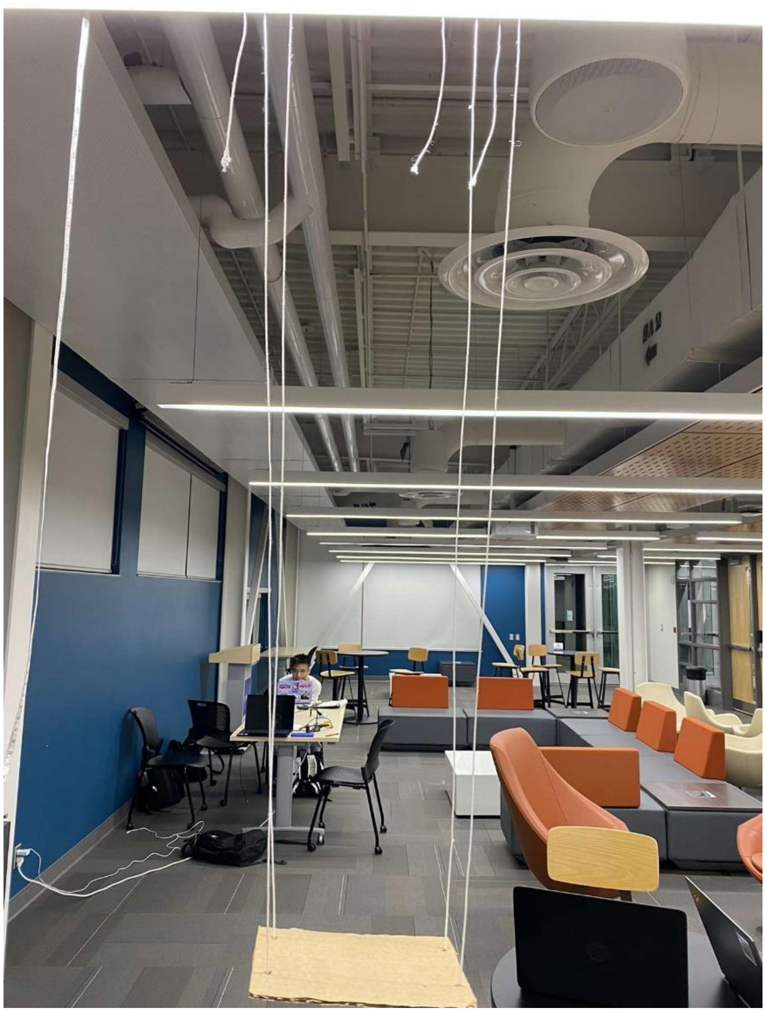
2. Materials

List of materials

2. Materials

- Smartphone
- String
- Scotch tape
- Screwdriver
- cardboard
- Chairs
- Measuring tape
- broom stick

- **Photograph of set-up**



Schematic of set-up

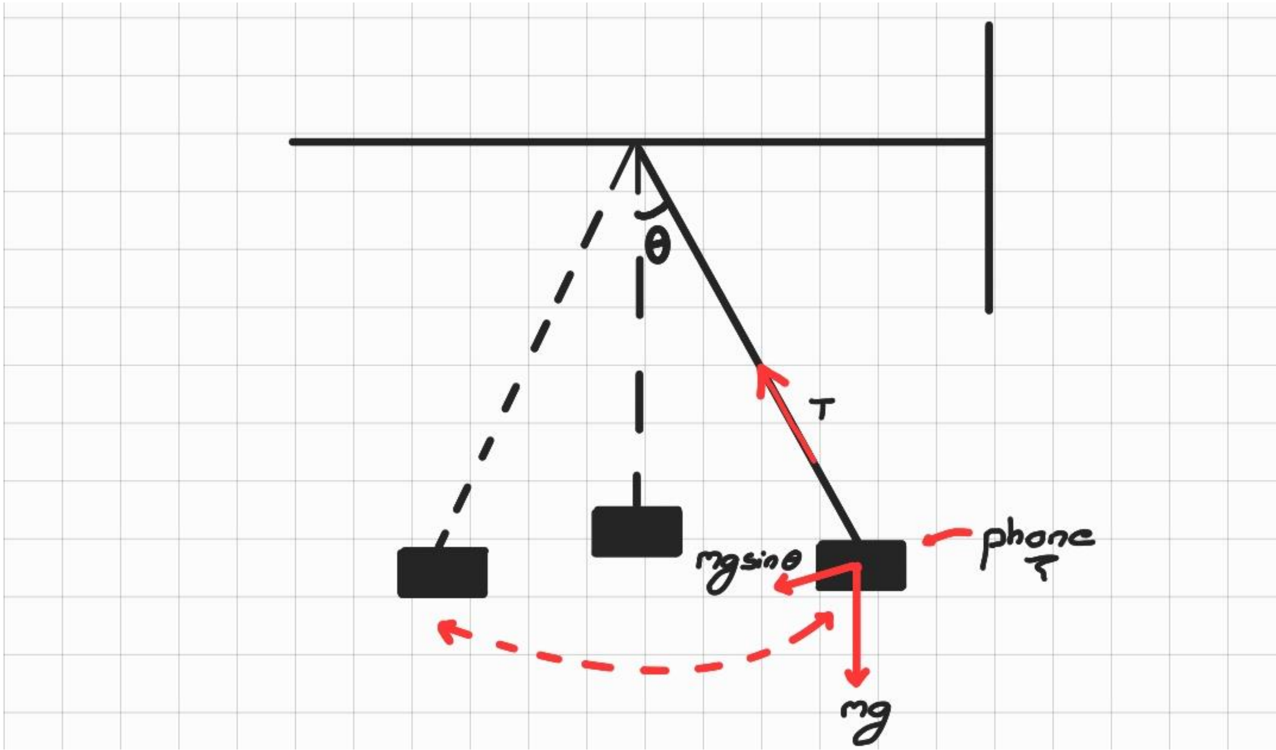


Figure 3: Schematic of set-up

3. Results

Table 1: Periods of Oscillation for Various Pendulum Lengths

Suggested Range of L	Measured L (cm)	T (sec)	f (Hz)	g (m/s^2)
110 cm -140 cm	115±0.05	1.99	0.50	11.48
90 cm - 110 cm	94±0.05	1.76	0.57	11.96
80 cm – 90 cm	85±0.05	1.59	0.52	11.74
70 cm – 80 cm	74±0.05	1.60	0.57	10.65
60 cm - 70 cm	60±0.05	1.56	0.62	10.20

50 cm – 60 cm	53±0.05	1.45	0.98	10.22
40 cm – 50 cm	42±0.05	1.23	0.78	10.60
30 cm - 40 cm	32 ±0.05	1.15	0.85	9.95
20 cm - 30 cm	21±0.05	0.85	1.15	10.63
10 cm – 20 cm	12±0.05	0.69	1.38	9.45

✓ Calculation of $\bar{g} \pm \sigma_{\bar{g}}$. Show the main equations and use Matlab to obtain the actual values.

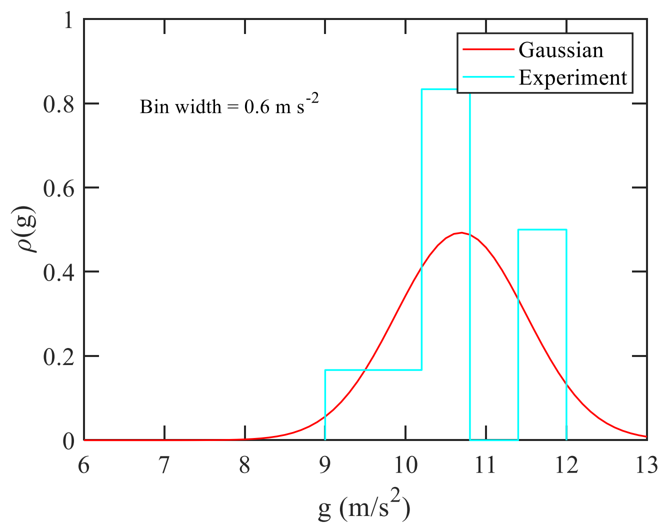
$$\bar{g} = \frac{g_1+g_2+g_3+g_4+g_5+g_6+g_7+g_8+g_9+g_{10}}{10}$$

$$= 10{,}6880$$

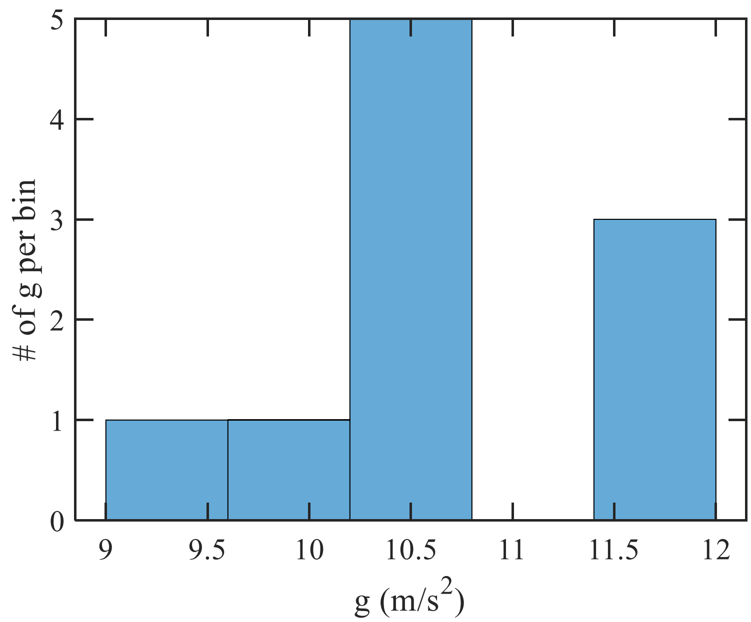
$$\sigma_{\bar{g}} = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2(\sigma_x)^2+\left(\frac{n}{g}\right)^2(\sigma_g)^2}$$

$$= \pm 0{,}8$$

✓ Histogram plot of g values. Does it have a bell-shaped curve?



✓ Plot your experimental values of period (T) versus length of your pendulum. Include the theory curve on graph.



Recall: Uncertainties σ are to be quoted with 1 significant figure. Note the variable value associated with the uncertainty must be displayed with the correct number of significant figures.

4. Discussions

- ✓ A brief discussion of your observations.
- ✓ Give the possible sources of errors for this experiment.
- ✓ Provide ways to improve the experience.

Note: **(no more than one page)**

In the basic pendulum experiment, a mass suspended from a string is observed to oscillate; the period of oscillation is affected by the gravitational acceleration and string length. Air resistance, friction at the pivot point, and inaccurate measurements are examples of potential sources of error. To improve accuracy, it is recommended to use low-friction materials to reduce air resistance, lubricate the pivot point, calibrate the string length precisely, and use precise timing techniques like photogate systems. Multiple trials, averaging results, and routine equipment inspections all help to increase reliability, which guarantees a more exact and accurate experiment execution.